BIOLOGY OF ANTICHAETA MELANOSOMA (DIPTERA: SCIOMYZIDAE), WITH NOTES ON PARASITOID BRACONIDAE AND ICHNEUMONIDAE (HYMENOPTERA)

Lloyd Knutson
Systematic Entomology Laboratory, IIBIII, Agr. Res. Serv., USDA, Beltsville, Maryland 20705

Jay Abercrombie
U. S. Army Environmental Hygiene Agency, Regional Division—North, Fort George G. Meade, Maryland 20755

ABSTRACT—Flies of the genus *Antichaeta* are among the few insects known to kill and feed solely on the eggs of snails during at least part of their life cycle. Females of the North American *A. melanosoma* lay their eggs only onto egg masses of an aquatic snail, *Aplexa hypnorum*, found in vernal ponds, swamps, and woodland pools. Young larvae feed only on snail embryos, but older larvae also prey on adult *A. hypnorum*. The life cycle of the fly is synchronized with seasonal changes in the water level of the ephemeral habitat and with the seasonal behavior of the food snail. At least 7 species of parasitoid Hymenoptera (Braconidae and Ichneumonidae) appear to have life cycles closely correlated with *A. melanosoma*, which provides them an availability of host larvae at the time of mating and oviposition. Adult flies and wasps emerge sequentially in the spring from overwintered puparia.

We are pleased to present this paper in honor of our good friend and colleague, Dr. Alan Stone, despite the fact that he has not had the good fortune to work on this superior group of flies.

The only insects known to feed exclusively, during at least part of their development, on the eggs of molluscs are larvae of *Antichaeta* Haliday (Diptera: Sciomyzidae) (Fisher and Orth, 1964; Knutson, 1966) and of *Megaselia aequalis* (Wood) (Diptera: Phoridae) (Robinson and Foote, 1968). The genus *Antichaeta* includes six palearctic and eight nearctic species, none of which is holarctic in distribution. An undescribed species is known from Michoacan, Mexico (K. Valley, pers. comm.). The adults are found on herbaceous vegetation around the margin of various aquatic and damp habitats and never appear to be particularly abundant.

The first species of Sciomyzidae reported to feed primarily on snail eggs was a western North American species, *A. testacea* Melander (Fisher and Orth, 1964). Subsequently, Knutson (1966) reported on the life histories of two European species, *A. analis* (Meigen) and *A. brevipennis* (Zetterstedt), whose larvae feed during part of the life cycle on snail eggs.

Antichaeta melanosoma Melander is the most common nearctic member of the genus. This paper presents for the first time informa-

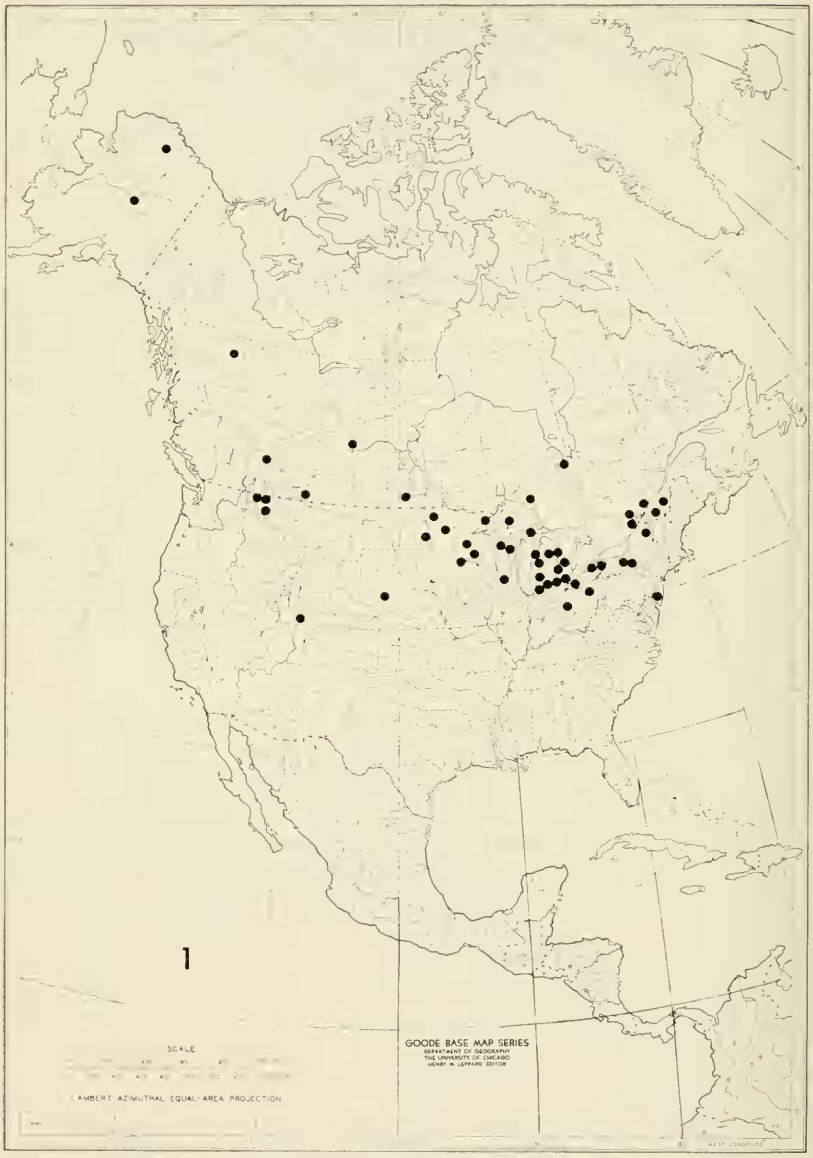


Fig. 1, Distribution of *Antichaeta melanosoma*.

tion on its life cycle, host preference, and natural enemies. The seasonal relationships of *A. melanosoma* to its principal snail host and its hymenopterous parasitoids living in the same vernal aquatic habitats are discussed.

From the known northern and western limits, ranging from Alaska (Umiat) to Utah (Vernal), *A. melanosoma* extends eastward to Quebec (Berthierville) and New Jersey (Burlington Co.) (fig. 1). The range of the fly is almost as extensive as that of its principal food snail, *Aplexa hypnorum* (L.), which is found throughout North America from east of the Cascade Mountains to the Atlantic Coast and from Alaska and Hudson Bay south to the vicinity of the Ohio River.

The breeding habitats seem to be limited to vernal ponds, swamps, and woodland pools. Such places are water-filled during spring, but they are almost or completely dry by early to midsummer. The life cycle of the fly is intimately associated with these changes in water level and with the seasonal behavior of *Aplexa hypnorum*, which also occurs abundantly in such vernal situations. *Antichaeta melanosoma*, in fact, exhibits more such temporally correlated life cycle characteristics than any of the approximately 200 species of Sciomyzidae that have been reared to date, except certain species of *Renocera* (Foote, 1975).

The general aspect of the habitat apparently has little influence on the fitness of the site as a breeding place for *A. melanosoma*; the seasonal change in water level is the critical factor. This was demonstrated dramatically at the two sites near Brooktondale, New York, where most of the field work was carried out. One locality (junction of Van Demark and Landon Roads) is a vernal pond (10 × 10 m) partially shaded by *Ulmus americana* L., *U. rubra* Muhl., *Pyrus malus* L., and *Pinus strobus* L. The other locality (Lounsbery Road), which is 1 km to the east, is an extensive dense, heavily shaded, mixed woods (consisting chiefly of *Acer saccharum* Marsh., *Carya ovata* (Mill.), *Quercus* sp., and *Tsuga canadensis* L.) in which there are many very small (3 × 3 m) vernal pools. On April 13, 1966, most of the vernal pond was filled to a depth of 0.5 m, and the vernal pools contained 0.2 to 0.3 m of water. The vernal pond supports a dense growth of *Carex* and *Juncus* and is bordered by *Onoclea*, *Solidago*, *Aster*, *Frageria*, and other herbaceous vegetation. The small vernal pools have a thick mat of dead and decaying leaves over the mud bottom and are surrounded by luxuriant growths of vegetation, mainly *Iris pseudacorus* L. *Aplexa hypnorum* was by far the most abundant aquatic gastropod at both localities. Aquatic molluscs were represented by a few *Lymnaea palustris* (Müller) and many fingernail clams (Sphaeriidae) in the vernal pools at Lounsbery Road, but these were not found in the vernal pond. A few terrestrial snails (*Oxyloma* sp., *Cionella lubrica* (Müller), *Discus patulus* (Deshayes), and the slug *Deroceras reticulatus* (Müller) were found on the slightly

higher ground between the pools in the wet woods on Lounsbery Road. *Derocerus reticulatus* also was present at the vernal pond. The water levels at the two sites changed at about the same rate, although the dead leaves in the bottom of the shaded pools remained damp longer than did the relatively bare floor of the vernal pond. In 1965, standing water had disappeared from both places by May 22. Other Sciomyzidae present at the vernal pond were: *Atrichomelina pubera* (Loew), *Pherbellia nana* (Fallén), *Tetanocera loewi* Steyskal, and *T. plebeia* Loew (all common) and *Dictya pictipes* (Loew) (rare). *Atrichomelina pubera* and *P. nana* were common around the vernal pools, but *Pteromicra pectorosa* (Hendel), *P. sphenura* Steyskal, *Renocera longipes* (Loew), *Tetanocera clara* Loew, *T. loewi*, *T. oxia* Steyskal, and *T. plebeia* were rather rare. The aquatic predators *Sepedon armipes* Loew, *S. fuscipennis* Loew, and *Elgiva sundewalli* Kloet and Hincks were abundant at the margin of an exposed farm pond only 30 m from the vernal pools, but these species never were found at the pools.

Other localities in New York where *A. melanosoma* were collected include: Montezuma Marsh at the town of Seneca Lake; a grove of *Alnus* and *Populus* in a marsh at the junction of New York Route 13 and Floral Avenue, Ithaca; a vernal swamp southeast of Albion; and a vernal swamp and pond at the junction of U. S. Route 20 and Savage Road, about 5 km west of Geneva. A specimen in the University of Minnesota Collection was taken in a "tamarack swamp" in Hennepin Co., Minnesota.

In northwestern Montana, adult *A. canadensis* (Curran) and *A. melanosoma* occurred together in the same vernal pool in a coniferous forest. Eggs and larvae of both species were found in egg masses of *Aplexa hypnorum*. (B. A. Foote, pers. comm.).

Laboratory observations were based on rearings initiated with eggs, larvae of all three instars, pupae, and adults collected at the two localities near Brooktondale during 1965. Supplemental information in regard to habitat and emergence and mating of adults was provided by notes associated with pupae collected at several localities in central New York during 1957 and 1958 by B. A. Foote.

A short and simple epigamic routine was noticed when recently emerged males were placed with recently emerged females. The male took a position directly in front of the female, facing her, and with his head about 4.0 mm from her head. The male moved his front legs rapidly and jerkily apart and together again for a few seconds before mounting the female, with his head above her head. During mating, the male's front tarsi were placed on the parafrontal regions of the female's head, the apices of his middle tibiae rested on the basicostal margins of her half-outstretched wings, and his hind tarsi grasped her postabdomen.

Adults in breeding jars occasionally were seen feeding on the sides of egg masses of *Aplexa hypnorum*.

Adults (fig. 2) collected on June 6 mated in the laboratory the same day. In nature, mating may occur much earlier than observed in the laboratory; some adults mated within 24 hours after they emerged from puparia in the laboratory on March 28. In central New York, mating begins at least as early as May 22; a female collected on that date and kept without a male in the laboratory subsequently laid viable eggs.

Eggs were found in nature on June 5, but collections of young third-instar larvae on the same date show that oviposition in nature begins at least as early as May 29. Two females that emerged in the laboratory on April 20 and 21 laid their first eggs 4 to 16 days later, respectively. One of these females laid 181 eggs (May 7 to 27), and the other laid 319 (April 24 to May 27). (B. A. Foote, pers. comm., notes that most of the oviposition recorded in rearings in northwestern Montana occurred during July). Females readily oviposited onto egg masses of *Aplexa hypnorum, Physa* sp., and *Lymnaea palustris*. but they did not lay eggs on living or dead snails, on fresh vegetation, or on any other substrate available in the breeding jars. One to 27 eggs, usually about ten, were laid onto each egg mass in the laboratory. However, infested egg masses of *A. hypnorum* collected in nature bore only one to four eggs each. The fly eggs rested on the surface of the snail egg masses. Each egg of *A. melanosoma* was enclosed (except the anterior and posterior apices) by a thin coat of clear, colorless, gelatinous material which probably is secreted during the process of oviposition. The incubation period was 24 to 48 hours at 21 to 27 C.

Many eggs were laid on egg masses of *Lymnaea palustris* (Lymnaeidae) but most of these larvae died during the first stadium. Only a few larvae developed to the third stadium on *L. palustris*, and none formed puparia. Successful rearings from hatching to puparium formation were obtained mainly with egg masses of *Aplexa hypnorum* and to a lesser extent with egg masses of *Physa* sp. (both members of Physidae). Larvae that hatched on eggs of *L. palustris* either starved or migrated to egg masses of *A. hypnorum* or *Physa* sp. when the latter were added to the rearing containers. In nature, first-, second-, and third-instar larvae were found feeding only in egg masses of *A. hypnorum*. The food habits of North American species of *Antichaeta* are summarized in Table 1.

Each newly hatched larva immediately entered the snail egg mass upon which the egg had been laid. The larva did not lie freely in the gelatinous matrix while it was attempting to penetrate the egg, but crawled onto the surface of the spherical egg. The larva's posterior spiracles were completely without contact with the air unless the

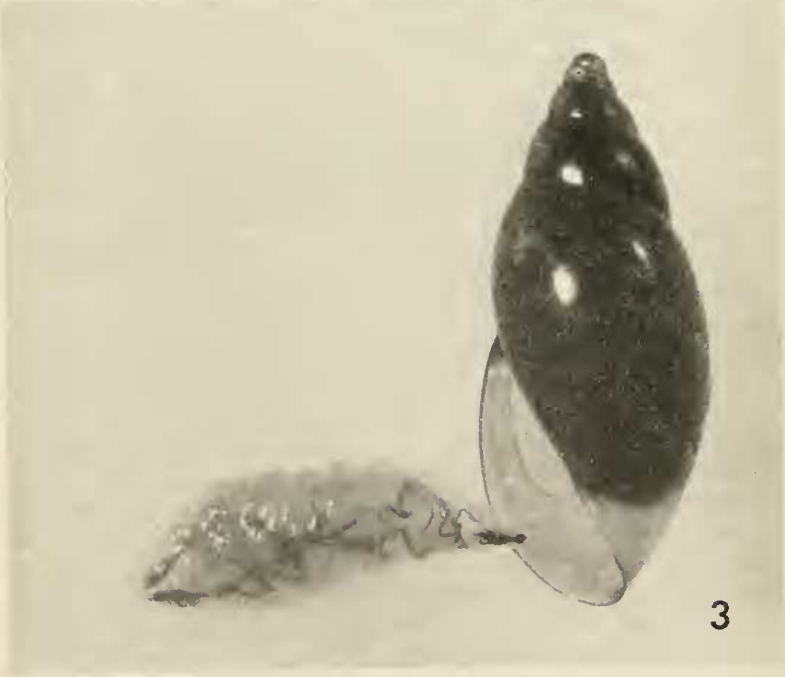


Fig. 2, *Antichaeta melanosoma*, adult, female. Fig. 3, third instar larva of *Antichaeta melanosoma* attacking adult *Aplexa hypnorum*.

Table 1.—Food habits of North American species of *Antichaeta*

Antichaeta Species	Gastropod Eggs Utilized	Reference
borealis Foote	*Oxyloma, Catinella*	Robinson (1966)
canadensis (Curran)	*Aplexa*	Foote (rearing notes)
fulva Steyskal	*Lymnaea*	Foote (rearing notes)
johnsoni (Cresson)	unknown	—
melanosoma Melander	*Aplexa*	Knutson and Abercrombie (present paper)
robiginosa Melander	unknown	—
testacea Melander	*Oxyloma, Succinea*	Fisher and Orth (1964)
vernalis Fisher and Orth	unknown	—

egg being attacked was very near the wall of the egg capsule. During the 12 to 24 hours after hatching, rapid and rhythmic back and forth rasping movements of the mouthhooks and post-oral spin band succeeded in rupturing the tough chorion. However, first-instar larvae that penetrated into the gelatinous matrix of *Lymnaea palustris* egg masses did not seem to break through the chorions of those eggs. Development of a few larvae on eggs of *L. palustris* may have been due to accidental rupture of the eggs during transferral from aquaria to the breeding jars. First-instar larvae consumed the contents of a freshly laid or mature egg of *A. hypnorum* and *Physa* sp. in less than one day. and then they crawled through the gelatinous matrix and penetrated other eggs. The first stadium lasted two to three days. By the second day the larva had developed to such a size that its posterior spiracles could be extended above the surface of the mass. During laboratory rearings many egg masses were so heavily infested that the crowded conditions forced even first instar larvae to move from one mass to another. The low numbers of fly eggs on each snail egg mass in nature (usually only one or two and never more than four) suggest that the first and second stadia normally are completed in the egg mass upon which the fly eggs were laid. This is suggested also by the discovery in nature of an egg mass of *A. hypnorum* containing one first-instar exivium and a second-instar larva which subsequently left the original egg capsule and entered a second just after it molted to the third-instar. A larva consumed 75 eggs in eleven egg masses of *A. hypnorum* between hatching on August 6 and forming a puparium on August 20 (B. A. Foote, pers. comm.).

Eggs and larvae were collected in nature on June 5 and 20. Of 19 egg masses of *A. hypnorum* found on moist, dead leaves and on the damp soil of the vernal pools on May 5, nine were not infested; one bore one embryonated fly egg; one contained one first-instar larva; two contained one second-instar larva each; three had two,

three, and four second-instar larvae; and three each had one third-instar larva. Two third-instar larvae were found crawling amongst living and dead *A. hypnorum* which had congregated at the damp bases of *Carex* near the center of the dried-up vernal pond on June 20. These larvae continued to eat eggs of *A. hypnorum* and *Physa* and mature *A. hypnorum* snails in the laboratory.

Larvae ate only eggs of *A. hypnorum* and *Physa* sp. (and occasionally eggs of *L. palustris*) during the two to three days of the second stadium. During the 10 to 30 days (usually about 15 days) of the third stadium, the larvae were noticeably more active and continued to show a strong predilection for egg capsules of *A. hypnorum* and *Physa* sp. However, third-instar larvae also killed and ate juvenile to mature *A. hypnorum* snails (fig. 3) (but not *Physa* sp., *L. palustris*, or *Helisoma trivolvis* (Say)). The larvae penetrated between the mantle and shell of the snail, killed the prey within a few hours, and consumed most of the tissues during the next 24 to 36 hours.

Newly-laid eggs of the palearctic species, *Antichaeta analis*, contain a thoroughly dispersed pinkish pigment which becomes concentrated in the gut as the embryo develops but disappears by the end of the second larval stadium (Knutson, 1966). Eggs of *A. melanosoma* obtained in Montana were pinkish (B. A. Foote, pers. comm.), but newly laid eggs of *A. melanosoma* from New York did not contain such pigment. However, a pinkish color began to appear in the posterior half of the gut of the larvae from New York at the beginning of the second stadium, and it developed and faded several times during the second and third stadia. Larvae often defecated a small amount of pinkish liquid when they were manipulated with a brush or otherwise disturbed. The color could be seen best in larvae fed on eggs of snails, but it was present also in the guts of larvae which ate mature snails. Flaccid, starved larvae as well as replete individuals often appeared pink. Exposure to a temperature of 5 C did not seem to influence the presence or absence of the pigment. The pink pigment is not an artifact of the laboratory environment or diet; some larvae collected in nature also were pink. We noted that the meconial fluid excreted by newly emerged adults also is bright pink; the meconial fluid produced by other Sciomyzidae is white.

Larvae formed their puparia on, in, and under damp cotton in the rearing boxes. Larvae which hatched from eggs in the laboratory on May 22 pupated between June 7 and 13; a larva collected on June 5 pupated in the laboratory on June 16; and larvae collected on June 20 formed puparia on July 20. The puparia were held at 76% relative humidity and room temperatures. All puparia appeared to contain living pupae, none molded or collapsed, but none produced flies.

Dr. B. A. Foote has provided me with the following information based on rearings carried out in northwestern Montana. "One of eight

puparia produced an adult female on September 10, 1966 after a pupal period of 13 days. Five of the remaining seven puparia produced adults after being refrigerated between October 19, 1966 and February 13, 1967. They had been continuously exposed to room temperatures for 52–62 days before being refrigerated. Adults emerged 15–18 days after being removed from the refrigerator."

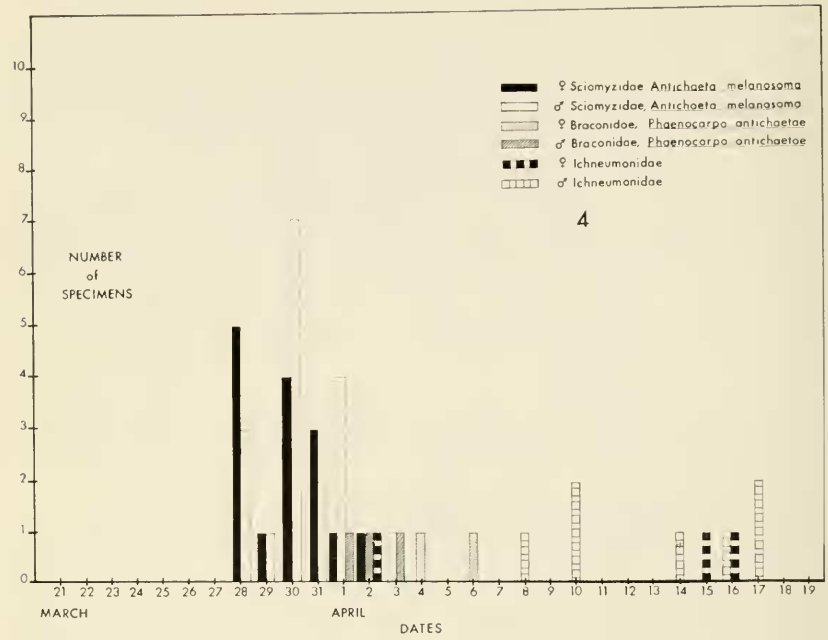
Puparia have been found in vernal situations between March 21 and May 11 at several places in central New York. These puparia produced adults between March 28 and May 16, 3 to 39 days (at room temperature) after they were collected. An apparently viable puparium was washed from plant debris collected from the bottom of the dried vernal pond on October 9, 1965, but did not produce an adult.

Adults were moderately long lived in the laboratory. Field-collected adults lived 4 to 62 days (8 females, 4 to 62 days; 1 male, 14 days). Adults which emerged in the laboratory lived 11 to 59 days (4 females, 11 to 39 days; 4 males, 11 to 59 days).

Dates of capture of adults range from May 11 (Ithaca, New York) to August 10 (Flathead Co., Montana, B. A. Foote), and they also have been taken on July 5 at Umiat, Alaska. *Antichaeta melanosoma* overwinters as a diapausing pupa, and adults emerge after the spring thaws, probably during late April and early May. Because the fly's oviposition sites are limited to egg masses of the food snail, egg laying by the fly probably does not begin until about the middle of May, when the receding waters of the vernal habitats expose suitable oviposition sites for the snails. With 15 to 38 days required for development from deposition of the egg to formation of the puparium, it seems likely that only one generation could be produced before hatching of the last eggs laid by the snails. Failure of puparia formed during June and July to produce adults within the subsequent three months further suggests that there is only one generation per year.

Parasitoid Hymenoptera

One species of Braconidae and 6 species of Ichneumonidae have been reared from overwintered puparia of *A. melanosoma* collected in the field. Puparia were collected in New York during early spring, 1966, and were transported to the laboratory for isolation and observation. The collecting site was the wooded, vernal pond at the junction of U. S. 20 and Savage Road, about 5 km west of Geneva. Puparia of *Antichaeta* were collected among floating litter and debris scooped from the pond in buckets. The pond was ice covered during March, at the time of our first collection. Separation of puparia from other materials was done in the laboratory. Individual puparia were placed in separate glass vials fitted with cotton plugs and held in a humid chamber. Vials were examined daily, and emerged adults


♀ Sciomyzidae Antichaeta melanosoma
♂ Sciomyzidae Antichaeta melanosoma
♀ Braconidae, Phaenocarpa antichaetae
♂ Braconidae, Phaenocarpa antichaetae
♀ Ichneumonidae
♂ Ichneumonidae
4
NUMBER of SPECIMENS
0 1 2 3 4 5 6 7 8 9 10
21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
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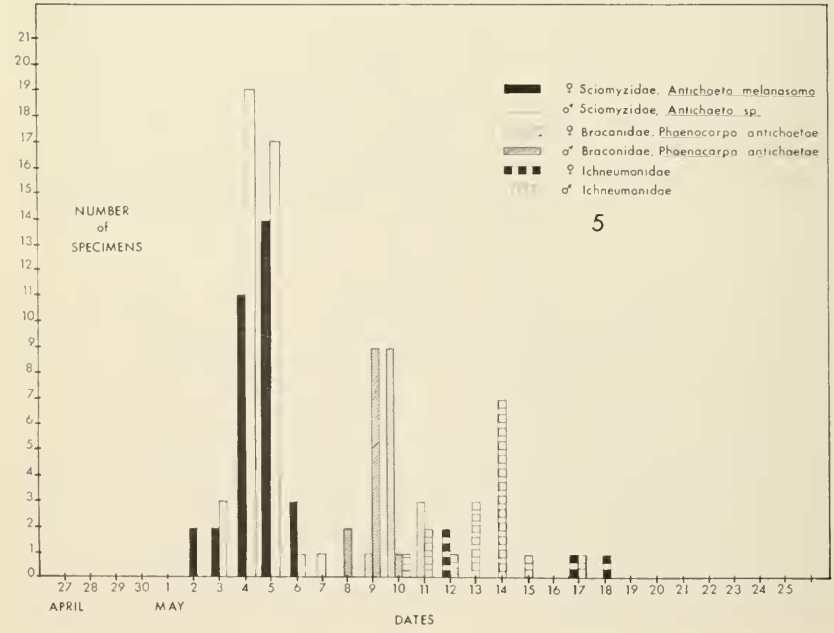
♀ Sciomyzidae, Antichaeta melanosoma
♂ Sciomyzidae, Antichaeta sp.
♀ Bracanidae, Phaenocarpa antichaetae
♂ Braconidae, Phaenocarpa antichaetae
♀ Ichneumonidae
♂ Ichneumonidae
5
NUMBER of SPECIMENS
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
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were removed for observation in breeding jars or were allowed to feed for 1–2 days before killing and pinning.

Emergence of adult flies and parasitoid wasps from the samples consistently occurred in the following sequence. Flies began emerging 5–7 days after collection, with peak eclosion from days 7 to 9. Braconidae began emerging on day 11, with a peak occurring on day 13. The first Ichneumonidae emerged from days 12 to 13, but their peak emergence occurred much later, at about day 17 (see figs. 4 and 5).

Sequential emergence of parasitic wasps from puparia of *Antichaeta* was first noted in a sample of 56 overwintering puparia collected from the vernal pond on March 21, 1966. All of the flies (33 specimens) emerged from March 28 to April 3. The Braconidae, represented by 5 specimens of *Phaenocarpa antichaetae* Fischer, emerged from April 1 to 6. Nine specimens of Ichneumonidae, representing 3 species, emerged from April 8 to 17. An exception among the Ichneumonidae was a lone female of another species (*Phygadeuon* sp. 2 of W. R. M. Mason) which emerged April 2. This date is toward the end of the period of fly emergence and in the midst of the peak eclosion for Braconidae. (Another specimen of *Phygadeuon* sp. 2 was collected in 1962 at the same locality from a puparium of *A. melanosoma*. The puparium was collected April 14 and a male wasp emerged on April 23.) These findings are summarized in fig. 4.

An even more striking example of sequential emergence was provided by a larger sample of 134 overwintering puparia taken at the same location on April 27, 1966. Between May 2 and 7, 72 adults of *Antichaeta* emerged. Of the Braconidae, 25 *Phaenocarpa antichaetae* emerged from May 8 to 11. The same 3 species of Ichneumonidae (20 specimens) emerged from May 10 to 18 (fig. 5). As in the first collection, there was a slight overlap of Braconidae and Ichneumonidae, with members of both families emerging on the same day. On May 10, a male of *Mesoleptus* (sp. 3 of W. R. M. Mason) was the only ichneumonid to emerge; there were 10 Braconidae produced that day. On May 11, 3 female Braconidae and 2 male Ichneumonidae emerged. By May 12, female Ichneumonidae were emerging along with males, but no additional Braconidae appeared. Most Bacronidae and Ichneumonidae emerged in well-defined peaks separated by about 4–5 days.

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Fig. 4, emergence pattern of Sciomyzidae, Braconidae, and Ichneumonidae from overwintering puparia of *Antichaeta melanosoma* collected March 21, 1966. Fig. 5, emergence pattern of Sciomyzidae, Braconidae, and Ichneumonidae from overwintering puparia of *Antichaeta* spp. collected April 27, 1966. The male fly that emerged on May 7 was *A. borealis* Foote. All other flies and puparia were *A. melanosoma*.

Braconidae

Phaenocarpa antichaetae was described from specimens reared in this study (Fischer, 1974), and the species is known only from the pond west of Geneva. All of the Braconidae reared from puparia were this species.

About 1% of the puparia from our March collection were parasitized by *P. antichaetae*. In the April collection, about 21% of the puparia were parasitized by *P. antichaetae*. Three adults (one female and two males) from the March collection were placed in breeding jars after emergence. They fed readily on a mixture of brewer's yeast, powdered milk, and honey. However, mating was never observed, and the female did not oviposit into larvae of Sciomyzidae placed in the jar. Adults lived 3–19 days in the laboratory (one female, 6 days; 2 males, 3 and 19 days). The sex ratio of emerged *P. antichaetae* was almost exactly 1:1.

Ichneumonidae

The Ichneumonidae reared from the fly puparia represented 6 species in 3 genera. All are undescribed, but 4 species were assigned identification numbers by W. R. M. Mason of Agriculture Canada, who kindly made the determinations during 1967. All 6 species are members of the tribe Hemitelini, subfamily Cryptinae.

A male of a new species (questionably placed in the genus *Mastrus*) emerged April 8 from a puparium collected March 21. He fed readily on the same artificial food as did *P. antichaetae* and lived 25 days in the laboratory. A female of this new species emerged May 12 from a puparium collected April 27. Other species of *Mastrus* parasitize a great variety of hosts, including Lepidoptera and Hymenoptera (Diprionidae, Tenthredinidae, and Ichneumonidae) (Townes and Townes, 1951).

Mesoleptus sp. 3 was the most common ichneumonid parasitizing *Antichaeta*. Three males were obtained from the March collection and 14 males and one female emerged from puparia collected April 27. Another species of *Mesoleptus* ([*M. declivus* (Prochancer)]) has been reported parasitizing Sciomyzidae in New York. Ashmead (1901) described it as *Atractodes sepedontis* reared from a puparium of *Sepedon fuscipennis*.

In 1966, only 1 specimen of *Phygadeuon* sp. 2 emerged from puparia of *Antichaeta melanosoma*. A female emerged April 2 from a puparium collected March 21 and lived only 3 days in the laboratory. *Phygadeuon* sp. 7 was rather common. Twelve specimens were collected: 3 males and 2 females from the March 21 collection and 5 males and 2 females from the April 27 collection. Thus the ratio of males to females was 2:1. A female of this species lived 40 days in the labora-

tory. *Phygadeuon*, like *Mesoleptus*, parasitizes muscoid Diptera. It has been reared from Anthomyiidae, Sciomyzidae, Tephritidae, Tachinidae, and Muscidae (Townes and Townes, 1951; Disney, 1964; Fisher and Orth, 1964; Walkley, 1967).

In addition to the four above species, two additional species of Ichneumonidae have been obtained from overwintering puparia of *A. melanosoma* during earlier collections in New York. *Mesoleptus* sp. near *declivus* emerged May 6, 1962 from a puparium collected at the pond west of Geneva on April 28. *Phygadeuon* sp. 1 near *trichops* was represented by three specimens; two puparia collected April 28, 1962, from the pond west of Geneva produced wasps on May 8 and 14; a puparium collected at Brooktondale on April 14, 1962, produced another specimen on May 6.

Discussion

The particularly close associations that have developed among the snail host *Aplexa hypnorum*, the fly *Antichaeta melanosoma*, and the seven species of parasitoid wasps exhibit a close correlation with each other at all stages of the life cycles and also with fluctuations in their ephemeral habitat. This correlation begins with the exposure of egg capsules of *A. hypnorum* as the water level drops and as females of *A. melanosoma* seek oviposition sites, continues with egg-laying wasps searching for suitable larvae or pupae for parasitization, and finishes with the final pupation of *A. melanosoma* in the moist areas that still remain in the habitat. Larvae of *A. melanosoma* are protected from desiccation by continuing to feed on moist snail tissues when vernal ponds have dried up. They further escape dessication by the behavior of the host snail which usually seeks damp places. It is likely that during this time larvae or even pupae are most susceptible to parasitization by Braconidae and Ichneumonidae. The fact that as many as seven species of wasps oviposit into *A. melanosoma* indicates that the fly is probably easily and frequently exposed to parasitization. Townes (1971) reports that ovipositing females of Ichneumonidae are attracted to microhabitats where suitable hosts may be found. O'Neill (1973) generally found the same to be true for two species of parasitoid Hymenoptera in the family Diapriidae.

A further example of the close association of *A. melanosoma* with its vernal pool habitat is a pupal diapause preventing emergence until the following spring. Only one generation is produced each year. The wasp parasitoids of *A. melanosoma* also probably undergo a diapause, or at least a quiescent period, since they too emerge in the spring at a time when different age classes of host larvae or pupae are present in which to lay their eggs. Griffiths (1964) reported that

braconid parasites of Agromyzidae emerge from puparia from a few days up to two or three weeks later than the host flies, thus allowing an availability of host larvae at the time of mating and egg-laying.

The further sequential emergence pattern exhibited by the well-defined peaks separating Braconidae from Ichneumonidae suggests that an isolating mechanism to restrict or limit competition may be operating in this vernal habitat. The diminution of competition for the same resource (i.e., host flies) and the adaptation to different ecological niches on a temporal plane may permit coexistence among these species of parasitoid wasps.

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FIRST RECORDS OF MEONEURA VAGANS FROM THE NORTHEASTERN UNITED STATES (DIPTERA: MILICHIIDAE)

The filth fly genus *Meoneura* is represented in the Nearctic Region by 13 species, many known only from one or a handful of localities (Sabrosky 1965, *In* Stone, *et al.*, USDA Agr. Hdbk. 276:728–733). Six of the species, including *M. vagans* (Fallén), are Holarctic. The genus was poorly known in North America until recently, when Sabrosky (1959, Ann. Entomol. Soc. Amer. 52: 17–26) revised the Nearctic species, describing 5 as new and recording 4 for the first time from North America. Later, Sabrosky (1961, Entomol. News. 72:229–234) described *M. californica* from the United States.

Collin (1930, Entomol. Mon. Mag. 66:82–89) collected adults of *M. vagans* on carrion and stated that this species was common in several areas in England. Sabrosky (1959) recorded *M. vagans* in North America only from Isle Royale, Michigan (1 male and 1 female collected 3–7 August 1936), and since that time no reports of additional collections have appeared.

On 17–18 June 1976, I collected 21 adults (20 males, 1 female) of *M. vagans* in Hummelstown, Dauphin County, Pennsylvania, sweeping over the body of a dead snapping turtle at the edge of a woodland. In November 1976, I received from L. L. Pechuman and J. A. Schafrik, Cornell University, a female fly collected at Ithaca, New York, 4 August 1925 and determined as *M. vagans* by S. W. Frost. I compared this specimen with my lone female and tentatively confirmed Frost's determination. Curtis W. Sabrosky kindly examined the specimen, compared it with American and European material of *vagans*, and agreed with my conclusion.

These records represent a considerable range extension for *M. vagans* in North America. The small size of many filth flies and their rather restricted habits are probably responsible for the paucity of collection records. The specimens of *M. vagans* are deposited in the collections of the U.S. National Museum of Natural History, Washington, DC; Cornell University, Ithaca, NY; and the Pennsylvania Department of Agriculture, Harrisburg, PA.

KARL VALLEY, *Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania 17120.*